**U.S. HOUSE OF REPRESENTATIVES**
**COMMITTEE ON SCIENCE**

# HEARING CHARTER

***U.S. Competitiveness: The Innovation Challenge***

**Thursday, July 21, 2005**
**10:00 a.m. - 12:00 p.m.**
**2318 Rayburn House Office Building**

## 1. Purpose

On Thursday, July 21, 2005, the House Science Committee will hold a hearing to examine the relationship between federal science and engineering research and education investments and U.S. economic competitiveness.

## 2. Witnesses

**Mr. Nicholas Donofrio** is Senior Vice President for Technology and Manufacturing at IBM Corporation.

**Mr. John Morgridge** is Chairman of Cisco Systems, Incorporated, and part-time professor at Stanford University's Graduate School of Business. From 1988 to 1995, Mr. Morgridge was CEO and President of Cisco.

**Dr. William Brody** is the President of The Johns Hopkins University. He has previously served as Director of the Department of Radiology, professor of electrical and computer engineering, and professor of biomedical engineering at Johns Hopkins, and radiologist-in-chief at The Johns Hopkins Hospital. He is also co-chair of the Council on Competitiveness National Innovation Initiative.

## 3. Overarching Questions

- How do federal science and engineering research and education programs foster innovation and contribute to U.S. economic competitiveness?

- How is the global competitive landscape changing, particularly with regard to innovation capacity, and what does this mean for future U.S. economic performance? What are the principal innovation-related challenges U.S. businesses face in terms of competing in the global economy?

- How can research and development (R&D) and math, science, and engineering education and training better contribute to the nation's innovation system and the U.S. competitive position? What specific steps should the federal government take to ensure that the U.S. remains the world leader in innovation?

## 4. Brief Overview

- The importance of a strong scientific and technological enterprise as a primary factor in driving economic growth is well-established. Substantial and sustained U.S. investments in research and education over the last 50 years spawned an abundance of technological breakthroughs that transformed American society and helped the U.S. to become the world's dominant economy. Economists estimate that these technological advances have been responsible for up to half of U.S. economic growth since the end of World War II. The relationship between innovation and economic growth has only grown in recent years as the world shifts to an increasingly knowledge-based economy.

- While the U.S. continues to lead the world in innovation capacity—R&D spending, number of scientists and engineers, scientific output, etc.—recent indicators of the level of U.S. support for research relative to other countries show that this lead may be slipping. Overall U.S. federal funding for R&D as a percentage of gross domestic product (GDP) has declined significantly since its peak in 1965, and the focus of this R&D has shifted away from the physical sciences, mathematics, and engineering—the areas of R&D historically most closely correlated with innovation and economic growth.

- At the same time, other nations—particularly emergent nations such as China and India—have recognized the importance of innovation to economic growth, and are pouring resources into their scientific and technological infrastructure, rapidly building their innovation capacity and dramatically increasing their ability to compete with U.S. businesses on the world stage.

- It has become increasingly apparent that the growing innovation capacity of foreign competitors, combined with the rise of the global economy and a relative erosion of federal support for innovation in the U.S., could present a long-term challenge to U.S. economic competitiveness.

- As a result, some industry and academic leaders have raised concerns that U.S. government policy has been slow to react to the rapidly changing competitive landscape. In particular, calls from U.S. industry for a revitalization of the U.S. innovation system have become louder and more frequent. Numerous business associations representing nearly every industry sector are now calling on the federal government to respond to the competitiveness challenge by increasing investments in the science and engineering research and education.

## 5. Background

*History of U.S. R&D Funding*

Prior to World War II, the private sector funded most research and development activity in the U. S. Federal government support was uncoordinated and targeted toward solving a small number of specific problems. The onset of the war led to a substantial (and successful) investment and effort to harness science and technology to meet the challenges of the war. In 1945, President Roosevelt's science advisor, Vannevar Bush, published a seminal report entitled *Science: the Endless Frontier*, which argued that continued and expanded public support for long-term, fundamental scientific research was as an important of investment in peacetime as it was in wartime, noting that building the knowledge base would ultimately lead to accelerated innovation and greater future economic growth.

In response to the report, Congress made support for civilian fundamental research a national priority, creating the National Science Foundation (NSF) in 1950. The Soviet launch of Sputnik in 1957 further broadened federal support for science and technology, resulting in the creation of the National Aeronautics and Space Administration (NASA) and significant spending increases on R&D and math, science, and engineering education. Another important response to Sputnik was passage of the National Defense Education Act in 1958, which provided unprecedented resources for math and science education at the elementary, secondary, and postsecondary levels. Together these events led to a dramatic shift in the federal government's approach to funding research and education. In 1935, the federal government support for R&D comprised only 13 percent of overall U.S. expenditures. By 1962, the federal portion had risen to 70 percent. Today, the federal portion has declined to roughly 30 percent, in part because of increased development funding by the private sector.

*Role of R&D in Innovation*

These efforts placed the U.S. at the forefront of innovation by building a massive U.S. R&D enterprise and educating the next generation of scientists and engineers. Ultimately, this paid significant dividends for the nation. While economists are not able to precisely determine the economic impact of federal support for R&D, the advancements resulting from such support have undeniably transformed every aspect of American life. Computers, the Internet, lasers, jet aircraft and modern telecommunications are just a few examples of products made possible by federal R&D investments since World War II.

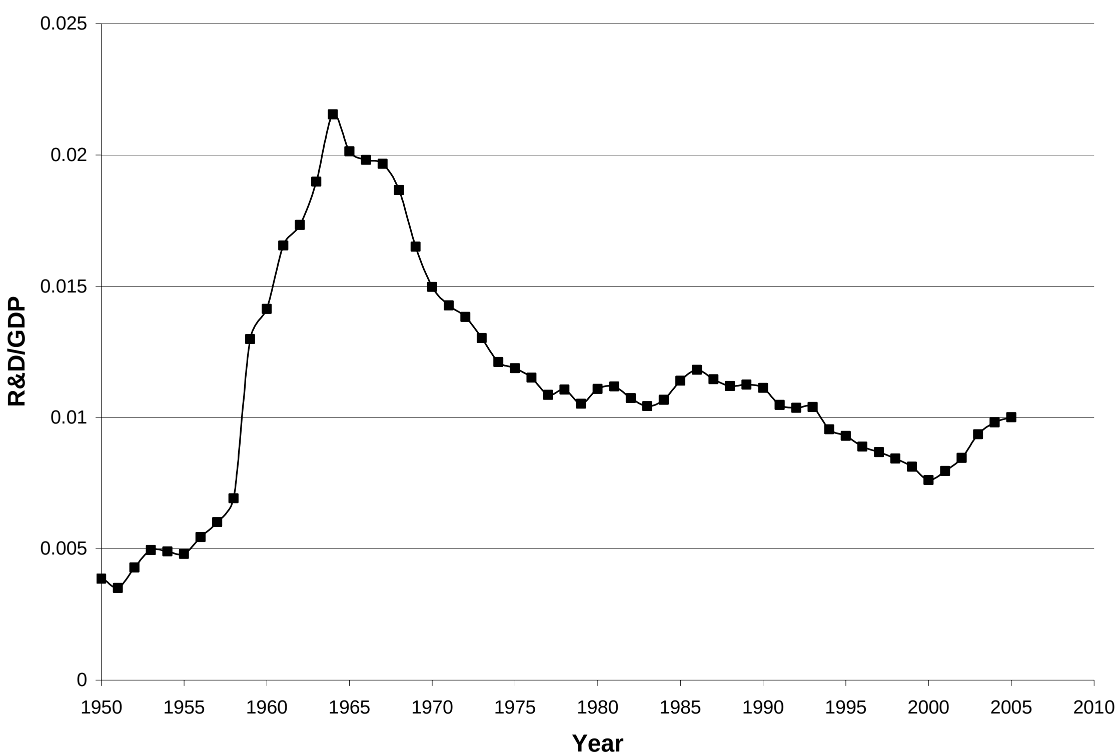
## 6. Issues

*Overall Federal Support for R&D*

The amount of the country's overall wealth devoted to federal R&D has declined significantly since the post-Sputnik surge in support for R&D. According to Office of Management and Budget statistics, in 1965, funding for R&D as a percentage of GDP (measured as outlays), also known as R&D intensity, was slightly over 2 percent (Chart 1). In 2005, it is estimated to be 1.07 percent.

While this ratio has recently begun to increase again, turning upward over the last five years, the majority of those increases have gone toward short-term defense development and homeland security applications. For example, the Department of Defense (DOD) R&D increases alone—most of which have supported development projects that have very little impact on innovation or broader economic development—has accounted for almost 70 percent of the overall R&D increases of the last five years. Of the remaining increases, 75 percent has gone to the National Institutes of Health (NIH) and the Department of Homeland Security (DHS). At $71 billion and $29 billion, respectively, the R&D budgets of DOD and NIH now account for over 75 percent of all federal R&D. Meanwhile, funding for the physical sciences and engineering—the areas historically most closely associated with innovation and economic growth—have been flat or declining for the last thirty years.

**Chart 1.** Federal Spending (Outlays) on Research and Development as a Percentage of GDP, FY1950-FY2005. (Source: Office of Management and Budget Historical Tables, Fiscal Year 2006.)



The increased emphasis on short-term development at the expense of longer-term basic and applied research, as well as the emphasis on defense and biomedical R&D spending, has led many in industry and academia (as well as the Science Committee) to question whether federal R&D priorities are appropriately balanced to maximize innovation and ensure long-term economic competitiveness.

Compounding these concerns, the long-term outlook for the federal budget does not favor future increases in discretionary spending (through which almost all R&D is funded). Absent major policy changes, the growth in mandatory federal spending—primarily for health and retirement benefits and payments on the national debt interest—will demand a significantly greater share of the government's resources.

*Shift of Private Sector R&D*

During the heyday of the corporate research laboratory in the middle decades of the 20th century, U.S. corporate laboratories supported all stages of R&D, from knowledge creation to applied research to product development, and were quite successful in their efforts to nurture innovation. The most notable example of this was AT&T's Bell Laboratories, which grew to be one of the world premier research organizations of the last century, developing numerous breakthrough technologies that changed American life, including transistors, lasers, fiber-optics, and communications satellites. Researchers at Bell Labs and other corporate laboratories were eligible for, and received, grants from federal research agencies such as NSF and DOD, but they received core support from the parent company and they conducted basic and applied research directed toward developing technology relevant to the company's business.

While overall growth of industry-funded R&D has remained strong in recent years, the focus of this R&D has shifted significantly away from longer-term basic research in favor of applied research and development more closely tied to product development. Because of market demands from investors to capitalize on R&D quickly, large corporate laboratories of the Bell Labs model are increasingly rare (notable exceptions include companies such as IBM and GE). Instead, corporations now focus research projects almost exclusively on lower-risk, late-stage R&D projects with commercial benefits, leaving the federal government as the predominant supporter of long-term basic research.

*Increasing Competitiveness of Foreign Countries*

While trends of support for the innovation system in the U.S. have showed signs of slowing and even eroding, other nations are committing significant new resources to building their science and technology enterprises. More than one-third of OECD (Organization for Economic Cooperation and Development) countries have increased government support for R&D by an average rate of over 5 percent annually since 1995. The European Union has recently established a target to achieve EU-wide R&D intensity of 3 percent of the EU economy by 2010. (By comparison, the current U.S. R&D intensity, public and private sector combined, is 2.6 percent of GDP.) Similarly, individual nations, including South Korea, Germany, the U.K. and Canada, have recently pledged to increase R&D spending as a percentage of GDP.

However, no nation has increased its support for innovation as dramatically as China. It has doubled its R&D intensity from 0.6 percent of its GDP in 1995 to 1.2 percent in 2002 (this during a time of rapid GDP growth). R&D investments in China by foreign corporations have also grown dramatically, with U.S. investments alone increasing from just $7 million in 1994 to over $500 million in 2000. China is now the third-largest performer of R&D in the world, behind only the U.S. and Japan.

The increased innovation capacity of other countries is also becoming evident in output-based R&D benchmarks. For example, the U.S. share of science and engineering publications published worldwide declined from 38 percent in 1988 to 31 percent in 2001, while Western Europe and Asia's share increased from 31 to 36 percent and 11 to 17 percent, respectively. Similar trends have occurred in the area of U.S. patent applications and citations in scientific journals.

*Education and Workforce Issues*

While the supply and demand of future scientists and engineers is notoriously difficult to predict, most experts believe that the transition to a knowledge-based economy will demand an increased quality and quantity of the world's scientific and technical workforce. As is the case with R&D figures, trends in the distribution of the world's science and engineering workforce are also unfavorable to long-term U.S. competitiveness.

The world is catching up and even surpassing the U.S. in higher education and the production of science and engineering specialists. China now graduates four times as many engineering students as the U.S., and South Korea, which has one-sixth the population of the U.S., graduates nearly the same number of engineers as the U.S. Moreover, most Western European and Asian countries graduate a significantly higher percentage of students in science and engineering. At the graduate level, the statistics are even more pronounced. In 1966, U.S. students accounted for approximately 76 percent of world's s science and engineering PhDs. In 2000, they accounted for only 36 percent. In contrast, China went from producing almost no science and engineering PhDs in 1975 to granting 13,000 PhDs in 2002, of which an estimated 70 percent were in science and engineering.

Meanwhile, the achievement and interest levels of U.S. students in science and engineering are quite low. According to the most recent international assessment, U.S. twelfth graders scored below average and among the lowest of participating nations in math and science general knowledge, and the comparative data of math and science assessment revealed a near-monopoly by Asia in the top scoring group for students in grades 4 and 8. These students are not on track to study college level science and engineering and, in fact, are unlikely ever to do so. Of the 25 – 30 percent of entering college freshmen with an interest in a science or engineering field, less than half complete a science or engineering degree in five years.

All of this is happening as the U.S. scientific and technical workforce is about to experience a high rate of retirement. One quarter of the current science and engineering workforce is over 50 years old. At the same time, the U.S. Department of Labor projects that new jobs requiring science, engineering and technical training will increase four times higher than the average national job growth rate.

*Industry Concerns and Reports*

As a result of the aforementioned trends, U.S. businesses have become increasingly vocal about concerns that the U.S. is in danger of losing its competitive advantage. In an effort to call attention to these concerns, several industry organizations have independently produced reports specifically examining the new competitiveness challenge and recommending possible courses of action to address it. Prominent among these efforts is the National Innovation Initiative (NII), a comprehensive undertaking by industry and university leaders (including those representing IBM, Cisco, and The Johns Hopkins University) to identify the origins of America's innovation challenges and prepare a call to action for U.S. companies to "innovate or abdicate." The December 2004 NII final report, *Innovate America: Thriving in a World of Challenge and Change*, intends to serve as a roadmap for policymakers, industry leaders, and others working to help America remain competitive in the world economy.

Other industry associations that have also produced recent reports include AeA (formerly the American Electronics Association), the Business Roundtable, Electronic Industries Alliance, National Association of Manufacturers, and TechNet. While the companies and industry sectors represented by these organizations varies widely, one general recommendation was common to all of the reports: the federal government needs to strengthen and re-energize investments in R&D and science and engineering education.

## 7. Witnesses Questions

The witnesses were asked to address the following questions in their testimony:

**Questions for Mr. Donofrio**

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges do your company and its industry sector face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the nation's innovation system and to the U.S. competitive position?
- What should the federal government be doing to strengthen the nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?

**Questions for Mr. Morgridge**

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges do your company and its industry sector face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the nation's innovation system and to the U.S. competitive position?
- What should the federal government be doing to strengthen the nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?

**Questions for Dr. Brody**

- What role does innovation play in bolstering U.S. competitiveness?
- What principal innovation challenges does the U.S. face in terms of competing in the global economy?
- How can research and development and math, science, and engineering education and training better contribute to the strength of the nation's innovation system and to the U.S. competitive position?
- What should the federal government be doing to strengthen the nation's innovation system, particularly with regard to federal programs to support research and technical workforce development?